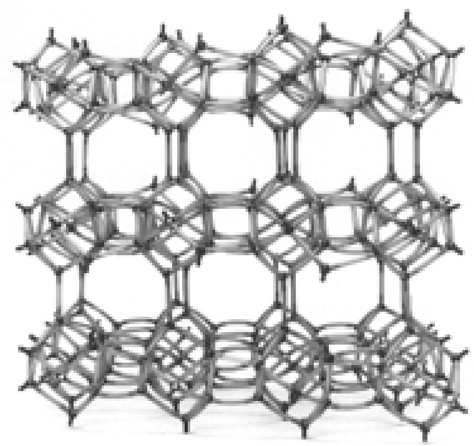
ZEOPLANT – Technical Product Description



View along cleavage plane of crystal plates

ZEOPLANT is a special blend of fully natural **inorganic** and **organic** compounds.

The inorganic components are:

- special **tecto silicate**, **mainly clinoptilolite** and volcanic glass
- a mixture of special **clay minerals mainly montmorillonite** and illite
- mineral nutrients

The tecto-silicates and the clay minerals –which are phillo-silicates- are two mineralogical groups with totally different behavior. The tecto silicates have rigid micro-porous structure, while the clay minerals are slightly swellable in water, those are elastic. Both components have a very important role in the water saving mechanism of ZEOPLANT.

The tecto silicate (clinoptilolite) framework remains rigid and his pore and channel sizes are nearly uniform, allowing the crystal to act as a molecular sieve. The porous clinoptilolite is host to water molecules and ions of potassium and calcium, as well as a variety of other positively charged ions, but only those of appropriate molecular size fit into the pores are admitted creating the “sieving” property.

One important property of the clinoptilolite is the ability to exchange cations. This is the trading of one charged ion for another on the crystal. One measure of this property is the cation exchange capacity (CEC).

There are many kinds of tecto silicates (clinoptilolite chabazite, phillipsite, mordenite, etc.) with varying physical and chemical properties. Crystalline structure and chemical composition account for the primary differences. Particle density, cation selectivity, modular pore size, and strength are only some of the properties that can differ depending on the type of the tecto silicate.

Clinoptilolites contain exchangeable cations. Exchange sites on natural clinoptilolites are primary occupied by 3 major cations: potassium (K), calcium (Ca) and Sodium (Na).
Other elements such as magnesium (Mg) may also be present.

In the tecto silicate used for Zeoplant is no sodium in the structure. Also very important is the ammonium ion binding capacity, the high enthalpy of water retention, and the bio-trace element storing capacity for Mn, Fe, Co, Zn, Cu, and other trace elements, which are given in the mineral crystalline structure.

The Montmorillinite:

1. It has the biggest water holding ability between all the minerals.

2. This mineral has a water insulation property. Prevents the lifting of the salty water, and in the same time keeps back the deep infiltration of the fresh, irrigation water.

3. It forms a very special organo-mineral - water - complex with the organic additive in Zeoplant, whose role is to keep the absorbed water available for the plant and to “communicate” with the clinoptilolite grains by diffusion.

Nutrient-additives:

1. Pre-charge the minerals with N and P for starter effect with strong roots grow .
2. Improves the bacterial activity for nitrification.

The organic compound is:

Natural organic fibre material

ZEOPLANT is approved to:

- Increase the water holding capacity of soils for a long period. Irrigation water amount can be reduced by 50%.
- Limit losses of water and nutrients due to leaching
- Reduce water evaporation in the soil
- Improve the physical properties of compact soils through good aeration
- Enhance plant growth. Water and nutrients are continuously available in the root zone for optimal absorption by plants.
- Protect the environment against drought and groundwater pollution
- Protect against soil erosion

TECHNICAL DATA

For the purpose of this evaluation the technical data of a typical "**Clinoptilolite"** is:

Approved amendment for horticulture & agriculture

Chemical Analysis

SIO_2	65% typically
Fe_2O_3	1-2% "
Al_2O_3	12% "

Total major oxides approx. 70%

CaO	3% typically
MgO	1% "
Na_2O & K_2O	< 4%

Total minor oxides typically 8%

LO1	< 15% typically 12%

Physical Characteristics:

Moisture retention 55%
pH neutral to alkaline

Bulk Density@ 2-4mm dia	typically 54.5lbs/ft^3
Maximum absorption	approx. 55% of its weight in water
Available water	33.5% pF4.2 (near permanent wilt point)
pH	neutral to alkaline
Cation exchange	>100meq/100g
Toxicity in soil	None under normal conditions
Storage requirements	None
Shelf life	Indefinite

ZEOPLANT – Observations

ZEOPLANT is a multi-component, special blend for soil treatment for water retention and best grass growth.

As ZEOPLANT is offered for golf course construction the USGA test requirement of ASTM F1815-97 Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, Particle Density, and Bulk Density of Putting green and Sports Turf Zone Mixes can be applied. **Zeoplant meets USGA guidelines in all regards.**

All these tests were done for learning these parameters, when the product development was done. The proper mixture was chosen from about 10 different possible mixtures, on the base of complexity of parameters.

The composition of Zeoplant is characteristic with balanced, slow breakdown. The mineral compounds – which carry the main role in effect of Zeoplant for the water saving – decompose very slowly.
The natural organic compounds which are added to the blend decompose more rapid, within 4-7 years, but those are participating in the all over picture of water balance of the soil-Zeoplant blend with a very low proportion, and having a major role only during the first 1-2 years to bind the components (soil particles, rhyolitic tuff and bentonites) together and build an active matrix.
Later, during the slow degradation process of the Zeolites, they are building enough fine particle clay minerals, which can take over the initial role of the organic compounds.

The phyllosilicate doesn't change its mineral structure anymore, because it is the final degradation product from many different silicates.
The degradation of Montmorillonite is only the reduction of the particle size, but this process is very slow (15-20 years).

The degradation process of the **rhyolitc tuff** has even a positive effect on the water saving! The result of the slow decomposition of clinoptilolite and volcanic glass are clay minerals (montmorillonite and illite).
These minerals increase the water retention of the soil and are very important to form organic-mineral complexes in the soil, with decomposed plant-residues.

This way, the general impression of the decomposition process of Zeoplant is positive, considered that the process is prolonged and is characterized not only with degradation, but also with building up processes of alteration in respect of water storing capacity of the soil.

The negative effect during the degradation process starts only, when some of the particles are already so small, that they are building colloidal solution with the irrigation water, and disappear from the upper soil level.
On the other hand, this degradation process is very slow. It can take even 25-30 years until the larger particles of 6-8 mm achieve this colloidal size limit.

The speed of degradation is influenced by several factors; some of those are:

- climate
- soil composition
- groundwater composition
- plant-root density
- composition of the spraying water
- microbiological life of the soil

Each of these main factors consists of several other impacts which considerably influence the degradation speed. Seeing that “average condition” doesn’t exist, the degradation process of Zeoplant can last from 10 to even 30-35 years.

Depending on the circumstances mentioned above, we can estimate that the **water saving effect** of Zeoplant will be kept almost unchanged during the first 5 years, then it starts to reduce very slowly during the next 10 -15 years down to approx. 30-50 % of the original value.

Zeoplant has a pH of neutral, between 6,8 – 7,5 in 10 % solution.

Zeoplant has to be used as a 4-5 % mixture in the soil.

ZEOPLANT has a high CEC.
The total cation storing capacity is even higher. The standard test method works with calcium and barium saturation. We use the ammonium saturation method and the sodium replacement method.

Please read the scientific article in our separate attachment APPENDIX 1:
www.zeolite.ca
Zeolites which are also tecto silicates are successfully used as water saving agent mainly in the US for golf courses!
One should know that ZEOPLANT has almost 4 times higher water holding capacity than a normal zeolite!
Click “Agriculture”, and then click “Golf Courses”
“Top soil” by Steve Anderson and Chang-Ho Ok, University of Missouri, June 2003

APPENDIX 1

Top Soil
By Steve Anderson and Chang-Ho Ok, University of Missouri, June 2003

Proper soil amendments and construction methods are your key to establishing firm greens, lush fairways, improved water percolation, greater air infiltration, and compaction resistance. These all lead to a perfect experience on the golf course. Sand is the primary ingredient for constructed root zones for Turfgrass. Traditionally, sand is the ideal medium for Bentgrass greens in terms of its physical characteristics (resistant to compaction, high infiltration rate and aeration porosity). However, sand has low water and nutrient retention capacity when compared to zeolite. It is therefore beneficial to add amendments to your sand base in order to increase water and nutrient retention. Zeolite has the same properties as sand along with the additional benefits. Unlike peat, which decomposes over time, zeolite is stable and durable.

Report: "Amendments & Construction Systems for Improving the Performance of Sand-Based Greens"

Procedure and Objectives

The University of Missouri-Columbia Turfgrass Research Center conducted a study to compare four treatments for root zone amendments and construction systems of putting greens. The measured responses were for establishment rate, quality and colour, root mass, soil physical and chemical properties, oxygen diffusion rates, drought avoidance, and fertilization needs as determined by tissue testing, nitrogen, phosphorus, and potassium leaching.

Two sands were used for the different root zone mixes in this study: a coarse (25%) and medium (52% sand was blended with Dakota Reed Sedge Peat for the USGA treatment and a medium (53%) and fine (37%) sand was used in the three California Profile Treatments. The particle size distributions in the root zone mixes for the California and USGA systems met the criteria for these systems.
The objective of the study was to compare these amendments and construction systems in terms of short- and long-term performance and resource efficiency by measuring responses such as: creeping bentgrass establishment, quality and color, root zone physical and chemical properties, and nitrogen and potassium leaching.

A. USGA Profile
• The USGA Profile consisted of 90% sand and 10% (vol.) Dakota Reed Sedge Peat with a 12" root zone mix over a 5" pea gravel layer (diameter of 0.10" to 0.25") over a drain.

B. California Profile
• The California Profile consisted of a 12" layer of sand overtop a 5" layer of silt loam with a drain at the top of the silt loam layer.

C. Two 'Modified' California Profiles.
• Researchers also studied two Modified California profile green treatments, each consisting of a 10" root zone mix over a 7" layer of silt loam with a drain at the top of the silt loam layer.

- o The first Modified Profile, referred to as the California-P treatment, consisted of 82% sand, 15% porous ceramic, and 3% humate.

- o The second Modified Profile, referred to as the California-Z treatment, consisted of 85% sand and 15% zeolite.

Results of Root Zone Properties

Researchers removed samples from the treatments and evaluated them in terms of saturated hydraulic conductivity, air-filled porosity, capillary porosity, total porosity and bulk density. Results of the physical property evaluation indicated that the construction treatments met the criteria set for California and USGA construction systems. **They found higher hydraulic conductivity values in the Profile and Zeolite amended California treatments compared to the other treatments**; they attributed this to the higher total porosity of these treatments. Field water infiltration measurements were taken two to three times each year. Results of field infiltration measurements for the study indicated that all treatments experienced a decrease in the infiltration rate over time.
Infiltration rates decreased over time, probably due to the increased accumulation of a thatch layer.

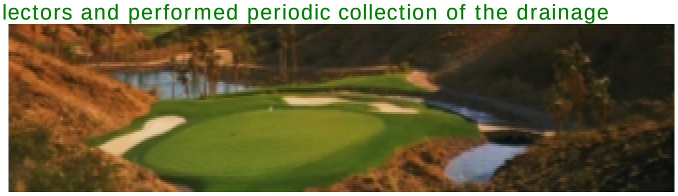
The zeolite-amended treatment had the highest field infiltration rates throughout the study. The USGA and the Profile and **Zeolite amended California treatments had increased values of cation exchange capacity (nutrient retention) in the root zone** compared to the un-amended California treatment. Researchers found the highest values were for the Profile-amended California treatment. **The zeolite amended California treatment contained more plant-available phosphorus and potassium compared to the other treatments**, while the Profile-amended California treatment contained high amounts of available phosphorus, calcium and magnesium relative to the un-amended California and USGA treatments. **Greater nutrient retention due to the additions of Zeolite and Profile seemed to correlate with higher average bentgrass quality and color ratings over the three-year study**. These results indicate that amending root zones with Profile or Zeolite may allow for maintaining high quality bentgrass with less frequent fertilizer inputs.

Results of Bentgrass Performance

Conditions for the bentgrass establishment during the fall of 1998 were optimum and bentgrass germination and fill-in were excellent. No differences among treatments occurred three months after seeding. **The zeolite-amended California treatment had the highest overall quality ratings during most of the experiment**.

Results of Nutrient Leaching

Researchers connected drains for each plot to outlet collectors and performed periodic collection of the drainage water to evaluate the quality of the water for nitrate and potassium concentrations. **The zeolite-amended California treatment consistently had the lowest potassium leachate concentration due to its higher cation exchange capacity (nutrient retention)**. The USGA treatment had the highest measured losses for potassium in June and September 1999.



Performance Summary

The results indicate that substituting Profile or Zeolite in place of peat will allow for the maintenance of high quality bentgrass greens with less fertilizer inputs. **The zeolite-amended California treatment had the highest infiltration rates, had the higher cation exchange capacities (nutrient retention) & plant nutrient levels, and produced the highest bentgrass quality and color throughout the experiment**. It is speculated that inorganic amendments such as zeolite may be superior replacements for peat as amendments in terms of some criteria for sand-based putting greens.

Chang-Ho Ok is a graduate student in horticulture and Steve Anderson is professor of soil science, both at the University of Missouri (Columbia, Mo.). Turfgrass Research & Information Report, 1999 from the University of Missouri-Columbia Turfgrass Research